



**Natural Resources Conservation Service**  
**CONSERVATION PRACTICE STANDARD**  
**WINDBREAK/SHELTERBELT ESTABLISHMENT**  
**CODE 380**  
**(ft)**

**DEFINITION**

Windbreaks or shelterbelts are single or multiple rows of trees or shrubs in linear configurations.

**PURPOSE**

This practice is used to achieve one or more of the following purpose(s):

- Reduce soil erosion from wind
- Protect plants from wind related damage
- Alter the microenvironment for enhancing plant growth
- Manage snow deposition
- Provide shelter for structures, animals, and people
- Enhance wildlife habitat
- Provide noise screens
- Provide visual screens
- Improve air quality by reducing and intercepting air borne particulate matter, chemicals and odors
- Delineate property and field boundaries
- Improve irrigation efficiency
- Increase carbon storage in biomass and soils
- Reduce energy use

**CONDITIONS WHERE PRACTICE APPLIES**

Apply this practice on any areas where linear plantings of woody plants are desired and suited for controlling wind, noise, and visual resources. Use other tree/shrub practices when wind, noise and visual problems are not concerns.

**CRITERIA**

Use the following criteria in planning and applying this practice. The general criteria apply to all windbreaks and shelterbelts, while additional listed criteria apply based on the intended purpose(s) of the practice.

**General Criteria Applicable to All Purposes**

**Selecting Plant Species**

See Table 1: *Selected Plants for Windbreak/Shelterbelt Plantings* for a list of tree/shrub species, their effective height class, and notable characteristics. Selected plants must be adapted to soil, site and climatic conditions. Refer to WOODLAND SUITABILITY -NC, FOTG Section II.

Species shall be suited for the planned practice purpose(s). Multiple species within rows may be used if heights, growth rates and growth forms are similar.

No plants on the Federal or state noxious weeds list shall be planted.

### Site Preparation and Planting

Site preparation should eliminate competing vegetation and leave the area in condition for the selected method of planting. It may range from nothing to strip tilling, strip chemical treatment or spot chemical/mechanical treatment depending on the site. Spot or strip treatments should be at least 4 feet in diameter or width. Refer to TREE/SHRUB SITE PREPARATION – NC Practice Code 490 for more information.

Planting shall be done at a time and manner to insure survival and growth of selected species. Only viable, high quality, and adapted planting stock or seed will be used.

The planting shall be protected from adverse impacts such as livestock grazing or fire.

Refer to TREE/SHRUB ESTABLISHMENT – Practice Standard 612 for further guidance on planting trees and shrubs.

### Density and Spacing

The location, layout and density of the planting will accomplish the intended purpose and function within a 20-year period.

*Spacing and minimum number of rows-* Use a minimum of 1 row of trees. If year-round protection is needed, that row must be evergreen trees. Use the guidelines below along with row minimums specified in additional criteria to achieve desired barrier densities for specific purposes.

<i>Within Row Spacing:</i>	
*Small shrubs (<8 ft. tall)	3-5 ft.
Shrub/short broadleaf (8-25 ft. tall)	5-8 ft.
Cedars	5-10 ft.
Tall trees	8-15 ft.
<i>Between Row Spacing:</i>	
*Shrub to short broadleaf (<25 ft. tall)	6-12 ft.
Cedars	10-15 ft.
Tall trees	12-20 ft.
* plant shrub lespedeza in rows 2-3 feet apart, 1.5 feet apart within row	

Spacing between individual plants shall be based on needed growing space for plant type and species, accommodation of maintenance equipment; and, desired characteristics of the stem(s), branches and canopy as required for a specific purpose. Additionally, adequate space must be left between the outside row of tree/shrubs and adjacent property lines or contrasting land uses to allow for needed maintenance.

For multi-row plantings, stagger plant spacing so that plants in one row are planted opposite openings in the adjacent row.

Use wider spacing if deciduous trees and evergreen trees are planted in adjacent rows of the windbreak to prevent faster growing deciduous species from overtopping conifers.

### Design Height, Protection and Sheltering

The maximum design height (H) for the windbreak or shelterbelt shall be the expected height of the tallest row of trees or shrubs at age 20 for the given site. The distance that protection extends from the windbreak leeward side is proportional to its height. The most effective zone of protection extends a distance 2 to 5 times its height (2H - 5H), while significant protection extends 10 times its height (10H).

Orient the windbreak as close to perpendicular to the prevailing or troublesome wind direction; and, on hilly terrain along the contour where possible.

The length of the windbreak will be sufficient to protect the site, including consideration for “end effect” and changes in wind direction.

### **Other General Criteria**

When high crown density trees are used in multi-row windbreaks, they should be planned for the outer, windward side of the barrier.

Roadways or other openings through the windbreak should be planned at an angle or curved to maintain wind protection integrity.

Avoid planting trees or shrubs where they will— interfere with structures (buildings, fences, etc.), create hazards to safety and health (road junctions, above or below ground utilities, etc.), or compromise legal entitlements (property lines, easements, right-of-ways, etc.).

Keep planned tree and shrub plantings at least 50 feet away from subsurface drains. Where a windbreak crosses functional subsurface (tile) drains, the subsurface drain will be replaced with a solid conduit through the width of the windbreak planting and extend 100 feet from exterior rows of large trees (> 60' mature height) and 75 feet from exterior rows of smaller trees and shrubs.

Moisture conservation or supplemental watering shall be provided for plant establishment and growth where natural precipitation is too low for the selected species or where site conditions warrant.

Comply with applicable federal, state and local laws and regulations during the installation, operation, and maintenance of this practice.

**Note:** Specific pesticide recommendations will be obtained from personnel who are licensed by the NC Department of Agriculture and Consumer Services in specialty area Agricultural Pest Plant Category O - in accordance with North Carolina Pesticide Laws and Regulations.

All pesticides must be registered for use by North Carolina and approved for use by the U.S. Environmental Protection Agency (EPA). Refer to the current issue of “North Carolina Agricultural Chemicals Manual” for guidelines, rules and regulations regarding use of pesticides. Users must **always** follow instructions and safety precautions on the container label when handling, applying, or storing pesticides.

### **Additional Criteria to Reduce Soil Erosion from Wind**

The interval between windbreaks shall be determined using current, approved, wind erosion technology. Interval widths shall not exceed that permitted by the soil loss tolerance (T), or other planned soil loss objective. Calculations shall account for the effects of other practices in the conservation management system.

Select species that are taller than crops or plants being protected.

For wind erosion control, temporary measures may be needed to supplement the windbreak until it is fully functional.

*Spacing and minimum number of rows* - windbreaks should be spaced to protect fields, and plants within an area 10 times the design height (10H) on the leeward side and 2 times the design height (2H) on the windward side of the windbreak. Use a minimum of 1 row of trees; if year round protection is needed, that row should be evergreen trees. For higher levels of protection, use at least 3 rows of trees/shrubs with at least one row being evergreen.

**Additional Criteria to Protect Plants from Wind Related Damage**

Follow the additional criteria to reduce soil erosion from wind.

**Additional Criteria to Alter the Microclimate for Enhancing Plant Growth**

Select tree/shrub species that will provide a beneficial symbiotic environment for the target crop or forage species.

Select tree/shrub density, width and orientation that will maximize the required microenvironment for target crops.

**Additional Criteria to Manage Snow Deposition**

The windbreak will be oriented as close to perpendicular to the snow-bearing wind as possible.

For snow distribution across a field, the windbreak density (during expected snow-producing months) shall not be less than 25 percent or greater than 50 percent. The interval between barriers will not exceed 20H.

For snow accumulation, the minimum barrier density, during expected snow-producing months, will be 50 percent.

The length of the windbreak will extend beyond the area being protected to allow for end drifts.

Windbreaks will be located so that snow deposition will not pose a health or safety problem, management constraints, or obstruct human, livestock or vehicular traffic.

Where water erosion and/or runoff from melting snow is a hazard, it shall be controlled by supporting practices.

**Additional Criteria to Provide Shelter for Structures, Animals and People**

For wind shelter protection, the minimum barrier density will be 65 percent during the months of most troublesome wind; and, the protected area must fall within a leeward distance of 10 times the design height (10H) of the windbreak.

Where animals are involved, drainage of snowmelt from the windbreak shall not flow across the livestock area; and, drainage of animal waste from the livestock area shall not flow into the windbreak.

*Spacing and minimum number of rows* - use a minimum of 1 row of trees; if year round protection is needed, that row should be evergreen trees. For higher levels of protection, use at least 3 rows of trees/shrubs with at least one row being evergreen. Again, the windbreak should be placed within a leeward distance of 10H of the protected site.

**Additional Criteria to Enhance Wildlife Habitat**

Plant species selection shall benefit targeted wildlife species. Design dimensions of the planting shall be adequate for targeted wildlife species.

*Spacing and minimum number of rows* - a minimum of 3 rows of trees and/or shrubs will be planted. Wider dimensions (more rows) are generally more optimal for wildlife. Shrubs should be located on outside rows.

*During winter months, direct sunlight is available on southern rows throughout the day. The opportunity to "sun" in a protected southern exposure decreases food needs for wildlife.*

**Additional Criteria to Provide Noise Screens**

Noise screens shall be at least 65 percent dense during all times of the year, as tall as practical; and, as close to the noise source as practical.

The length of the noise screen shall be twice as long as the distance from the noise source to the receiver.

For high-speed traffic noise, the barrier shall not be less than 65 feet wide. For moderate speed traffic noise, the barrier width shall not be less than 20 feet wide.

Select species that will produce a high-density barrier (evergreens), and plant these species as close as practical.

Species selected should be tolerant to noxious emissions, sand, gravel depositions or salt spray from traffic areas.

*Spacing and minimum number of rows* - use a minimum of 2 rows of trees, or 1 row of trees and 1 row of shrubs. At least one row must be evergreen trees.

#### **Additional Criteria to Provide Visual Screens**

Visual screens shall be located as close to the observer as possible with a density, height and width to sufficiently block the view between the area of concern and the sensitive area.

*Spacing and minimum number of rows* - use a minimum of 1 row of trees. If year-round screening is needed use at least 1 row of evergreen trees.

#### **Additional Criteria to Improve Air Quality by Reducing and Intercepting Air Borne Particulate Matter, Chemicals and Odors**

The windbreak interval shall be less than or equal to 10H depending on site conditions and related supporting conservation practices.

Windbreaks should be oriented perpendicular to the predominant wind direction, and between the source and the area sensitive to the source. They should be extensive enough to account for wind direction changes at critical times.

Select and maintain tree and shrub species with foliar and structural characteristics to optimize interception, adsorption and absorption of airborne chemicals and odors.

Windbreak density on the windward side of the problem source (i.e. particulate, chemical or odor) shall be greater than 50% to reduce the airflow into the source area, disrupt air flow around the source area and increase turbulence in the boundary area over the source area.

Windbreak density on the leeward side of the problem source, and windward of the area to be protected, shall be greater than 65%.

For poultry house particulate trapping, choose a species from Table 1 that is suitable for use near poultry house tunnel/ventilation fans.

*Spacing and minimum number of rows*- Use a minimum of 1 row of trees. If year-round protection is needed use at least 1 row of evergreen trees or shrubs.

For trapping particulates from poultry house tunnel fans: Plant at least one row of evergreen trees/shrubs within 25 feet on the fans for best results. Distances in excess of 50 feet may not provide sufficient particulate trapping. Other permanent barrier types (fencing, earth berms, mortar walls, etc.) may be needed in concert with vegetation to control particulates. Temporary barriers (netting, tall grass, straw bales) can be used while the living barrier is being established. Particulate filter barriers will need to be cleaned or rinsed periodically with fresh water spray; establish and/or maintain grass cover around the barrier to filter rinse water.

### **Additional Criteria to Delineate Property and Field Boundaries**

Delineation of property and field boundaries is generally a secondary criterion for windbreaks/shelterbelts and often results from establishing windbreaks/shelterbelts for other purposes. Align trees/shrubs with property and/or field boundaries where marking or delineation is important. Allow adequate space between the outside row of tree/shrubs and adjacent property lines or contrasting land uses to allow for needed maintenance.

*Spacing and minimum number of rows* - use a minimum of 1 row of trees.

### **Additional Criteria to Improve Irrigation Efficiency**

For sprinkler irrigation systems, the windbreak shall be as tall as the sprinkler heads and not interfere with the operation of the irrigation system.

*Spacing and minimum number of rows* - Use a minimum of 1 row of trees. If year-round efficiency is needed use at least 1 row of evergreen trees.

### **Additional Criteria to Increase Carbon Storage in Biomass and Soils**

Carbon sequestration is generally a secondary criterion for a windbreak/shelterbelt. For optimal carbon sequestration, select plants (or mixtures of plants) that are adapted to the site to assure strong health and vigor. Plant the appropriate FULL stocking rate for the site and maximize the size (width and length) of the windbreak to fit the site.

Some plants may fix carbon in biomass and soils more efficiently than others. Consult a professional for current research on adapted plants that sequester carbon more efficiently.

Minimize soil disturbance during establishment and maintenance of the windbreak/shelterbelt.

Prediction of carbon sequestration rates shall be made using current, approved carbon sequestration modeling technology.

## **CONSIDERATIONS**

Closer within row spacing will give quicker results due to canopy closure but may require thinning to maintain full crowns and prevent natural pruning of lower branches. Wider spacing may reduce or eliminate need for thinning or maintenance, but will greatly increase time for crowns to close and the windbreak to reach maximum effectiveness.

Consider using evergreens or species with showy flowers, brilliant fall foliage or persistent colorful fruits to enhance aesthetics. Additionally, species selections that produce nuts, fruits, wood products, seeds, flowers or other agricultural, forestry or wildlife beneficial products are appropriate and recommended if barrier/shelter effectiveness is not reduced.

When designing and locating a windbreak or shelterbelt, consider the impact upon the landowner's or public's view of the landscape.

Selection of plants for use in windbreaks should favor species or varieties tolerant to herbicides used in the area.

Plants that may be alternate hosts to undesirable pests should be avoided.

All plantings should complement natural features.

Tree or shrub rows should be oriented on or near the contour where water erosion is a concern. Where water erosion and/or runoff from melting snow is a hazard, it should be controlled by supporting practices.

Wildlife and pollinator needs should be considered when selecting tree or shrub species.

A shelterbelt can be used as a travel corridor to connect existing patches of wildlife habitat.

Species diversity, including use of native species, should be considered to benefit wildlife/pollinators and avoid loss of function due to species-specific pests.

Visual screens should be utilized to reduce neighbors' views of animal production and waste facilities, which may lead to reduced odor complaints associated with visual stimulus of olfactory senses.

In cropping systems select windbreak and shelterbelt species that minimize adverse affects to crop growth (e.g. shade, allelopathy, competing root systems or root sprouts).

Consider the needs/rights/requirements of livestock/poultry integrators when designing windbreaks/shelterbelts around contract confined animal operations.

Windbreaks for odor and chemical control increase in effectiveness as the amount of foliage available for intercept increases. Multiple row plantings (wider barrier) offer greater interception potential than do smaller, narrower plantings.

Field windbreaks to reduce wind erosion are most often needed in the coastal plain of eastern North Carolina; however, there are many other site specific uses for windbreaks that need to be considered in the planning process within all geographic regions of the state.

When windbreaks are aligned near right angle (0 to 22½ degrees) to the wind, there is no practical reduction in sheltered distance. Where possible, extend the ends of windbreaks beyond the area needing protection to account for end effects and allow for wind direction shifts.

Natural windbreaks of native hardwoods, such as oak and gum, 33 to 330 feet wide offer effective wind protection and wildlife habitat. The distance sheltered by natural windbreaks should be calculated using the methods herein. Natural windbreaks should be considered when forest land is cleared for agriculture.

A weed barrier/moisture conservation fabric (at least 4 feet wide) will improve establishment success of plant materials and help reduce rodent damage.

For quicker establishment and faster growth, consider using air-root pruned potted planting stock.

*This practice has the potential to affect National Register listed, or eligible, significant cultural resources (CULTURAL RESOURCES INFORMATION - NC, FOTG Section II). Follow NRCS state policy for considering cultural resources during planning.*

## PLANS AND SPECIFICATIONS

Specifications for applying this practice shall be prepared for each site and recorded using approved specification sheets, job sheets, technical notes, and narrative statements in the conservation plan, or other acceptable documentation.

Minimum documentation will include:

- Map showing location of windbreak.
- Plant materials or species to be planted.
- Plant spacing and arrangement.
- Number of rows and distance between rows.
- Site preparation and planting method(s).
- Site specific needs for soil amendments, cultural, pest management or other practices.
- Time or season of year to plant.
- Statement requiring compliance with all federal, state and local laws.



- Required operation and maintenance instructions.

## OPERATION AND MAINTENANCE

The following actions shall be carried out to insure that this practice functions as intended throughout its expected life. These actions include normal repetitive activities in the application and use of the practice (operation), and repair and upkeep of the practice (maintenance).

- Replacement of dead trees or shrubs will be continued until the barrier is functional. As a guide:
  - First 2 years: replace any dead plants found.
  - After 2 years: replace plants to maintain at least 85% survival, and not leave two adjacent dead plants.
- Supplemental water or weed barrier fabric will be provided as needed.
- Thin or prune the barrier to maintain its function.
- Inspect trees and shrubs periodically and protect from adverse impacts including insects, diseases, competing vegetation, fire and damage from livestock or wildlife.
- Protect windbreaks from herbicide damage, especially from adjacent cropland. Use directed sprays and management strategies to control drift.
- Periodically rinse off vegetation when barrier is used as a particulate filter.
- Field windbreaks may need to be root pruned to reduce sapping effects on adjacent cropland. Prune with a ripper, chisel or subsoil shank to a depth of 2 feet or more, parallel to the windbreak at a distance of  $\frac{1}{2}H$  of the highest trees at time of pruning. Root pruning can begin at age 4-6 years.
- Periodic applications of nutrients may be needed to maintain plant vigor.

## REFERENCES

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**Table 1: Selected Plants for Windbreak/Shelterbelt Plantings**

	Tree Shrub Common Name <i>Scientific Name</i>	Effective Height (ft.) Trees @ 20 years shrubs @ maturity	Notable Characteristics
DECIDUOUS TREES	Ash, Green <i>Fraxinus pensylvanica</i>	25-35	Suited to wetter sites. <b>Native</b>
	Black Gum <i>Nyssa sylvatica</i>	20-30	Bright red fall foliage. <b>Native</b>
	Carolina Laurelcherry <i>Prunus caroliniana</i>	25-35	Dense foliage, good soft mast production, suited to Coastal Plain. <b>Native</b>
	Chinkapin <i>Castanea pumilia</i>	15-20	Good food/cover for wildlife. <b>Native</b>
	Crepe Myrtle <i>Lagerstroemia indica</i>	15-25	Conspicuous spring flowers.
	Cypress, Bald <i>Taxodium distichum</i>	20-30	Suited to wet-moderately dry sites. <b>Native</b>
	Dogwood <i>Cornus spp.</i>	15-25	NC state flower, striking when in full bloom, some species shorter. <b>Native</b>
	Hawthorn <i>Crataegus spp.</i>	25-35	Red fall color and blooms. <b>Native</b>
	Maple, Red <i>Acer rubrum</i>	25-35	Red fall color and blooms. <b>Native</b>
	Oak, Pin, Red, Willow, White <i>Quercus spp</i>	25-35	Bronze to red fall foliage, numerous acorns (varying sizes), stately. <b>Native</b>
	Poplar, Yellow <i>Liriodendron tulipifera</i>	30-40	Flowers produce abundant nectar that bees utilize. <b>Native</b>
	Redbud, Eastern <i>Circus canadensis</i>	15-20	Numerous small pink flowers in spring, used by bees. <b>Native</b>
	Sassafras <i>Sassafras albidum</i>	15-25	Fragrant spring blooms. <b>Native</b>
	Sweetgum <i>Liquidambar styraciflua</i>	30-40	Yellow-red fall color, seed heads (gumballs) can be nuisance, fruitless types available. <b>Native</b>
	Sycamore <i>Platanus occidentalis</i>	30-40	Falling bark can be nuisance, mix with other species for disease control (anthracnose). <b>Native</b>
EVERGREEN /CONIFER TREES	Cedar, Eastern Red <i>Juniperus virginiana</i>	20-30	Keep away from apple orchard (host for cedar-apple rust), suitable for use near poultry tunnel fans. <b>Native</b>
	Cypress, Leland <i>X Cupressocyparis leylandii</i>	30-40	Shorter lifespan, suitable for use near poultry exhaust fans, prone to bagworms and canker.
	Holly, American <i>Ilex opaca</i>	20-30	Shade tolerant, male/female plants needed for berry production. <b>Native</b>
	Holly, other <i>Ilex spp.</i>	20-30	See American holly above, suitable for use near poultry tunnel fans, various varieties available.
	Pine, Loblolly <i>Pinus taeda</i>	40-55	Self prunes lower limbs so best suited to multi-row windbreak. <b>Native</b>
	Pine, Longleaf <i>Pinus palustris</i>	25-35	Plant containerized seedlings if possible. Good for droughty sites. See pine, loblolly above. <b>Native</b>
	Pine, White <i>Pinus strobes</i>	30-40	Does not tolerate pollution, generally more suited to mountains and foothills. <b>Native</b>

Table 1 continued on next page

**Table 1: Selected Plants for Windbreak/Shelterbelt Plantings (continued)**

	Tree Shrub Common Name <i>Scientific Name</i>	Effective Height (ft.) Trees @ 20 years age shrubs @ maturity	Notable Characteristics
SHRUBS	Bayberry (Southern Wax Myrtle) <i>Myrica sp.</i>	20-30	Salt tolerant, suitable for use near poultry tunnel fans, male/female plants needed for berry production. <b>Native</b>
	Bronze Elaeagnus <i>Elaeagnus pungens</i>	4-10	Evergreen, hearty, may be suitable for use near poultry tunnel fans, invasive-can spread easily.
	Bush Honeysuckle <i>Lonicera maackii</i>	8-12	Deciduous, normally in full leaf by critical wind erosion period, invasive-can spread easily.
	Chicksaw Plum <i>Prunus angustifolia</i>	15	Thicket forming, good soft mast, may not be suited to some mountain sites. <b>Native</b>
	Crabapple <i>Malus angustifolia</i>	15-20	Thicket forming, good soft mast. <b>Native</b>
	Pyracantha <i>Rosacea spp.</i>	10-15	Different growth shapes available, showy fruit, may be suitable for use near poultry tunnel fans.
	Sumac <i>Rhus copallinum</i>	5-10	Deciduous, should be planted with evergreens, flowering. <b>Native</b>
	Shrub Lespedeza <i>Lespedeza bicolor</i>	8-12	Deciduous, should be planted in combination with evergreens.
	VA-70 or Amquail Shrub Lespedeza <i>Lespedeza thunbergii</i>	5-7	Deciduous, should be planted in combination with evergreens.
Other locally available native, introduced or volunteer plant materials with similar growth rate, shape and size (check NRCS PLANTS Database for plant material information) may be used if reviewed and approved by NRCS-NC-ECS staff.			